Stellaris® LM4F120 LaunchPad Evaluation Kit

BoosterPack Development Guide

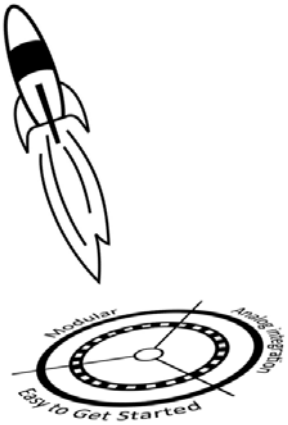

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Table of Contents

Chapter 1: Stellaris® LaunchPad and BoosterPack Expansion Concept and Overview 6
BoosterPack Functional Interface 7
BoosterPack XL Functional Interface 9
LaunchPad Power Interface 10
Special Consideration for Shared Pins 11
Stellaris LaunchPad Dimensions and Mating 11
BoosterPack Design Guidelines 12
Appendix A: Schematics 13
Appendix B: References 17

List of Figures

Figure 1-1. Stellaris® LM4F120 LaunchPad Evaluation Board 7

List of Tables

Table 1-1. LaunchPad BoosterPack Compatibility Summary 6
Table 1-2. J1Connector 8
Table 1-3. J2 Connector 8
Table 1-4. J3 Connector 9
Table 1-5. J4 Connector 9
Table 1-6. Stellaris® LaunchPad Jumper List 11

CHAPTER 1

Stellaris® LaunchPad and BoosterPack Expansion Concept and Overview

The Texas Instruments' Stellaris® LM4F120 LaunchPad concept is an extremely low-cost, expandable evaluation system for TI microcontrollers. This concept began with the tremendously successful MSP430™ LaunchPad which introduced a large number of engineers to the TI MSP430 family of microcontrollers. The TI Stellaris microcontroller family is expanding on that success by introducing the Stellaris® LM4F120 LaunchPad featuring the Stellaris ARM® Cortex™-M4F LM4F120H5QRFIG microcontroller.

A Stellaris LaunchPad consists of a target microcontroller, an in-circuit debug interface (ICDI) such as JTAG, a regulated power supply, a minimal microcontroller support circuit, a user interface, and a set of expansion headers. The expansion headers are referred to as the BoosterPack interface. A BoosterPack is an expansion card designed for this interface. This interface provides a mechanism for developers to easily extend the Stellaris LaunchPad with application- and user-specific functions.

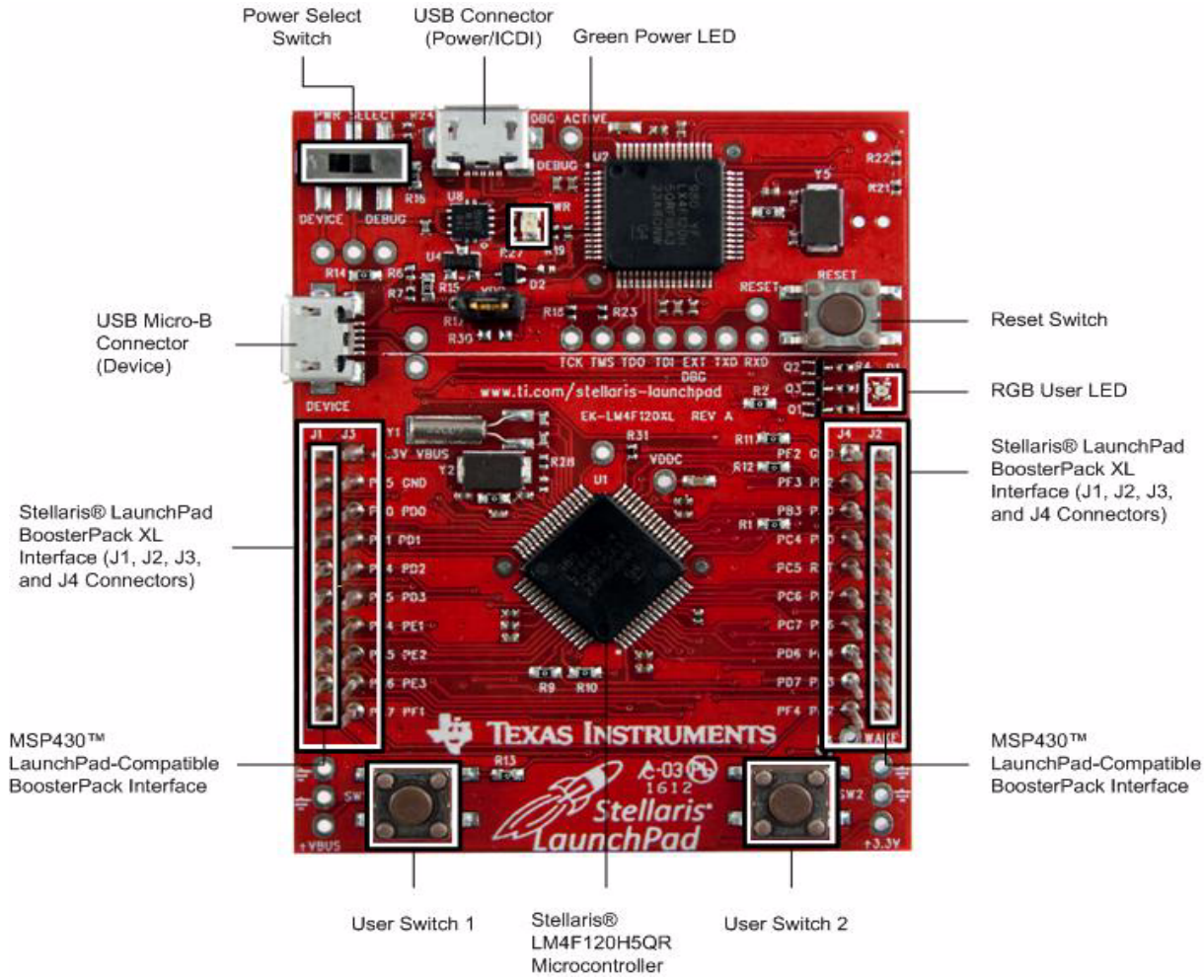
The Stellaris LaunchPad provides a BoosterPack interface that is compatible with the MSP430 LaunchPad. In addition, the Stellaris LaunchPad provides access to additional Stellaris functionality through an extended BoosterPack interface called the BoosterPack XL Interface. BoosterPack interfaces with highly similar functionality for expansion will be available for the Stellaris LaunchPad, in addition to microcontroller-family-specific functionality available on a BoosterPack XL Interface for additional options. Table 1-1 provides a summary of BoosterPack interface compatibility.

Table 1-1. LaunchPad BoosterPack Compatibility Summary

LaunchPad	Compatible with...	
	BoosterPack Interface	BoosterPack XL Interface
Stellaris LaunchPad	Yes	Yes
MSP430 LaunchPad	Yes	No
Other TI LaunchPads	Yes	No

This development guide provides necessary design information for developers who want to create BoosterPacks that extend the functionality of the Stellaris® LaunchPad using either the original BoosterPack or the BoosterPack XL Interface. Figure 1-1 on page 7 shows a photo of the Stellaris® LaunchPad.

Figure 1-1. Stellaris® LM4F120 LaunchPad Evaluation Board



BoosterPack Functional Interface

The Stellaris® LaunchPad's BoosterPack Interface provides compatibility with the original MSP430 LaunchPad's BoosterPack interface. This interface consists of the outer 10 pin headers. The pins are spaced 0.10-inch apart with the two headers located 1.8 inches apart.

Table 1-2, ”J1Connector” on page 8 and Table 1-3, ”J2 Connector” on page 8 provide information for which Stellaris microcontroller peripherals are routed to each of the interface pins. The J1 connector is located on the far left side of the Stellaris LaunchPad. The J2 connector is located on the far right side of the Stellaris LaunchPad. Software is used to configure the LM4F120 pin for one of the functions found in the table. Highlighted functions indicate configuration for compatibility with the MSP430 LaunchPad.

Table 1-2. J1Connector

J1 Pin	GPIO	Stellaris Pin	GPIOPCTL Register Setting							
			GPIOAMSEL	1	2	3	7	8	9	14
1.01	3.3 V									
1.02	PB5	57	AIN11	-	SSI2Fss	-	T1CCP1	CAN0Tx	-	-
1.03	PB0	45	-	U1Rx	-	-	T2CCP0	-	-	-
1.04	PB1	46	-	U1Tx	-	-	T2CCP1	-	-	-
1.05	PE4	59	AIN9	U5Rx	-	I2C2SCL	-	CAN0Rx	-	-
1.06	PE5	60	AIN8	U5Tx	-	I2C2SDA	-	CAN0Tx	-	-
1.07	PB4	58	AIN10	-	SSI2Clk	-	T1CCP0	CAN0Rx	-	-
1.08	PA5	22	-	-	SSI0Tx	-	-	-	-	-
1.09	PA6	23	-	-	-	I2C1SCL	-	-	-	-
1.10	PA7	24	-	-	-	I2C1SDA	-	-	-	-

Table 1-3. J2 Connector

J2 Pin	GPIO	Stellaris Pin	GPIOPCTL Register Setting							
			GPIOAMSEL	1	2	3	7	8	9	14
2.01	GND									
2.02	PB2	47	-	-	-	I2C0SCL	T3CCP0	-	-	-
2.03	PE0	9	AIN3	U7Rx	-	-	-	-	-	-
2.04[a]	PF0	28	-	U1RTS	SSI1Rx	CAN0Rx	T0CCP0	NMI	C0o	-
2.05	RESET									
2.06[b]	PB7	4	-	-	SSI2Tx	-	T0CCP1	-	-	-
2.07[c]	PB6	1	-	-	SSI2Rx	-	T0CCP0	-	-	-
2.08	PA4	21	-	-	SSI0Rx	-	-	-	-	-
2.09	PA3	20	-	-	SSI0Fss	-	-	-	-	-
2.10	PA2	19	-	-	SSI0Clk	-	-	-	-	-

a. Not recommended for BoosterPack use. J2.04 is a TEST pin on the MSP430 LaunchPad. This signal tied to on-board function via 0-Ω resistor.
b. J2.06 (PB7) is also connected via 0-Ω resistor to J3.04 (PD1) to provide MSP430 LaunchPad Compatible I2C SDA Signal.
c. J2.07 (PB6) is also connected via 0-Ω resistor to J3.03 (PD0) to provide MSP430 LaunchPad Compatible I2C SCL Signal

BoosterPack XL Functional Interface

The BoosterPack XL Interface consists of the J1 and J2 connectors as well as the inner 10-pin headers spaced 1.6 inches apart directly inside of the MSP430 LaunchPad-compatible BoosterPack interface headers. The pins are spaced on 0.10-inch centers. These inner 10-pin headers (connectors J3 and J4) are not intended to be compatible with other TI LaunchPads or LaunchPad XL's. This is a Stellaris-only interface. TI recommends that LaunchPads provide analog functions on the left side of the BoosterPack XL interface and timer or PWM functions on the right side of the BoosterPack XL interface. Stellaris conforms to these recommendations. No effort has been made to make this interface compatible with any other LaunchPad.

Table 1-4 and Table 1-5 show which Stellaris peripherals are routed to each pin of the Stellaris-only BoosterPack XL Interface pins. J3 is the inner left BoosterPack XL Interface header. J4 is the inner right BoosterPack XL Interface header. Software is used to configure the LMF4120 pin for one of the functions found in the table.

Table 1-4. J3 Connector

J3 Pin	GPIO	Stellaris Pin	GPIOPCTL Register Setting							
			GPIOAMSEL	1	2	3	7	8	9	14
3.01	5.0V									
3.02	GND									
3.03	PD0	61	AIN7	SSI3Clk	SSI1Clk	I2C3SCL	WT2CCP0	-	-	-
3.04	PD1	62	AIN6	SSI3Fss	SSI1Fss	I2C3SDA	WT2CCP1	-	-	-
3.05	PD2	63	AIN5	SSI3Rx	SSI1Rx	-	WT3CCP0	-	-	-
3.06	PD3	64	AIN4	SSI3Tx	SSI1Tx	-	WT3CCP1	-	-	-
3.07	PE1	8	AIN2	U7Tx	-	-	-	-	-	-
3.08	PE2	7	AIN1	-	-	-	-	-	-	-
3.09	PE3	6	AIN0	-	-	-	-	-	-	-
3.10[a]	PF1	29	-	U1CTS	SSI1Tx	-	T0CCP1	-	C1o	TRD1

a. Not recommended for BoosterPack use. This signal tied to on-board function via 0-Ω resistor.

Table 1-5. J4 Connector

J4 Pin	GPIO	Stellaris Pin	GPIOPCTL Register Setting							
			GPIOAMSEL	1	2	3	7	8	9	14
4.01[a]	PF2	30	-	-	SSI1Clk	-	T1CCP0	-	-	TRD0
4.02[a]	PF3	31	-	-	SSI1Fss	CAN0Tx	T1CCP1	-	-	TRCLK
4.03	PB3	48	-	-	-	I2C0SDA	T3CCP1	-	-	-
4.04	PC4	16	C1-	U4Rx	U1Rx	-	WT0CCP0	U1RTS	-	-
4.05	PC5	15	C1+	U4Tx	U1Tx	-	WT0CCP1	U1CTS	-	-
4.06	PC6	14	C0+	U3Rx	-	-	WT1CCP0	-	-	-

Table 1-5. J4 Connector (Continued)

J4 Pin	GPIO	Stellaris Pin	GPIOPCTL Register Setting							
			GPIOAMSEL	1	2	3	7	8	9	14
4.07	PC7	13	C0-	U3Tx	-	-	WT1CCP1	-	-	-
4.08	PD6	53	-	U2Rx	-	-	WT5CCP0	-	-	-
4.09	PD7	10	-	U2Tx	-	-	WT5CCP1	NMI	-	-
4.10[a]	PF4	5	-	-	-	-	T2CCP0	-	-	-

a. Not recommended for BoosterPack use. This signal tied to on-board function via 0-Ω resistor.

LaunchPad Power Interface

The Stellaris LaunchPad has provisions to provide power to a BoosterPack through either the BoosterPack interface or the BoosterPack XL Interface. The configuration of power and ground pins on both of these interfaces must be consistent across LaunchPads from all TI microcontroller families.

The Stellaris LaunchPad draws power from either of the on-board USB interfaces as selected by the power switch in the top left corner of the board. Typically, the USB connection provides 500 milliamps at 5 V to the Stellaris LaunchPad. The selected USB power source is made directly available to the BoosterPack XL Interface on the J3.01 pin. This is a direct connection with only small decoupling capacitors provided on the Stellaris LaunchPad.

All LaunchPads, including the Stellaris LaunchPad, also provide a 3.3-V supply on pin J1.01 of the BoosterPack interface. On the Stellaris LaunchPad, this is sourced by a TPS73633 LDO voltage regulator which converts the selected 5-V USB power to 3.3 V. The regulator is capable of sourcing 400 milliamps at 3.3 V. This 3.3-V supply is shared between the BoosterPack interface, the in-circuit debug interface (ICDI), and the target microcontroller. Therefore, under normal circumstances, about 300 to 350 milliamps are available to the BoosterPack interface. Detailed power management is left to the BoosterPack developer who must also manage the application to be run on the target microcontroller.

The Stellaris LaunchPad can be powered through an external supply on a BoosterPack. If providing power to the Stellaris LaunchPad from a BoosterPack, move the power select switch to select an unused USB connection to prevent power bus contention between the BoosterPack and the USB connection. Power may be supplied to either the 3.3 V or the 5.0-V system but not both. Providing external power to both 5 V and 3.3 V would result in a contention between the external power supplies and the Stellaris LaunchPad's voltage regulator. Providing only 3.3 V will result in some lost functionality such as the on-board LED’s. It may also result in reverse current leakage through the on-board voltage regulator. Therefore, it is recommended if providing power externally to use either the existing USB connections or an external 5-V supply from a BoosterPack.

Ground connections are available on pins J2.01 and J3.02. These provide a ground connection for both the BoosterPack interface and the BoosterPack XL Interface respectively.

Additional power and ground pins are available through labeled pins located in the extreme lower corners of the Stellaris LaunchPad. These are connected to the same 3.3 V, 5 V, and ground connections as the pins on the BoosterPack interface and the BoosterPack XL Interface.

Special Consideration for Shared Pins

To provide compatibility with the MSP430 LaunchPad's BoosterPack interface and to provide a maximum number of signals to the BoosterPack interface and BoosterPack XL Interface, it was necessary to route some signals to more than one pin. In addition, certain on-board functions such as the button and LED signals are available on the BoosterPack interface and BoosterPack XL Interface. A 0-Ω jumper resistor was installed for signals that are used for more than one purpose or routed to more than one GPIO. Removal of this jumper disconnects the functions. All jumpers are installed by default. A listing of these jumpers and their use is provided in Table 1-6.

Table 1-6. Stellaris® LaunchPad Jumper List

Resistor	Primary Function	Alternate Function	Comments
R1	Right User Switch	J2.04	Test pin on MSP430 LaunchPad. This connection along with R13 provides Hibernate wake to BoosterPack interface
R2	Red LED	To PF1 and J3.10	If removed: allows extra GPIO to the BoosterPack XL interface. If installed (default): allows booster pack to drive LED or sense LED state. Also provides Embedded Trace signal TRD1.
R8	Hibernate Wake	To PF0 and J2.04 via R1	Allows user switch 2 to wake device from hibernate. Also ties wake to J2.04 to allow BoosterPack to wake Stellaris LaunchPad from Hibernate.
R9	PB6 SSI2 TX on J2.07	PD0 I2C SCL on J2.07	Routes I2C from PD0 to J2.07 for MSP430 Stellaris LaunchPad compatibility. If using PD0 or PB6, the unused GPIO must be configured as an input or R9 removed.
R10	PB7 SSI2 RX on J2.06	PD1 I2C SDA on J2.06	Routes I2C from PD1 to J2.06 for MSP430 Stellaris LaunchPad compatibility. If using PD1 or PB7, the unused GPIO must be configured as an input or R9 removed.
R11	Blue LED	To PF2 and J4.01	If removed: allows extra GPIO to the BoosterPack XL interface. If installed (default): allows BoosterPack to drive LED or sense LED state. Also provides Embedded Trace signal TRD0.
R12	Green LED	To PF3 and J4.02	If removed: allows extra GPIO to the BoosterPack XL interface. If installed (default): allows BoosterPack to drive LED or sense LED state. Also provides Embedded Trace signal TRDCLK.
R13	Left User Switch	To PF4 and J4.10	If removed: allows extra GPIO to the BoosterPack XL interface. If installed (default): allows BoosterPack to simulate switch press or sense switch state.

Stellaris LaunchPad Dimensions and Mating

Figure 1-1 on page 7 shows a dimensional drawing of the Stellaris LaunchPad. J1 and J2 are 1.8 inches apart and constitute the BoosterPack interface. J3 and J4 are 1.6 inches apart and constitute the BoosterPack XL Interface. Other major board signals are available on unpopulated headers on a 0.1 inch grid. Dimensions to these signals are provided for convenience. These signals are subject to change or move across revisions of the Stellaris LaunchPad or future LaunchPads. It is recommended that BoosterPacks use only the BoosterPack interface and BoosterPack XL Interface. Use of other pins and signals is acceptable but these pins and signals can change at any time.

BoosterPack Design Guidelines

Follow these guidelines when designing your BoosterPack:

- BoosterPacks should not extend more than 0.350 inches above the center of the top BoosterPack interface pin.
- BoosterPacks should not extend more than 0.150 inches below the center of the bottom pin of the BoosterPack interface.

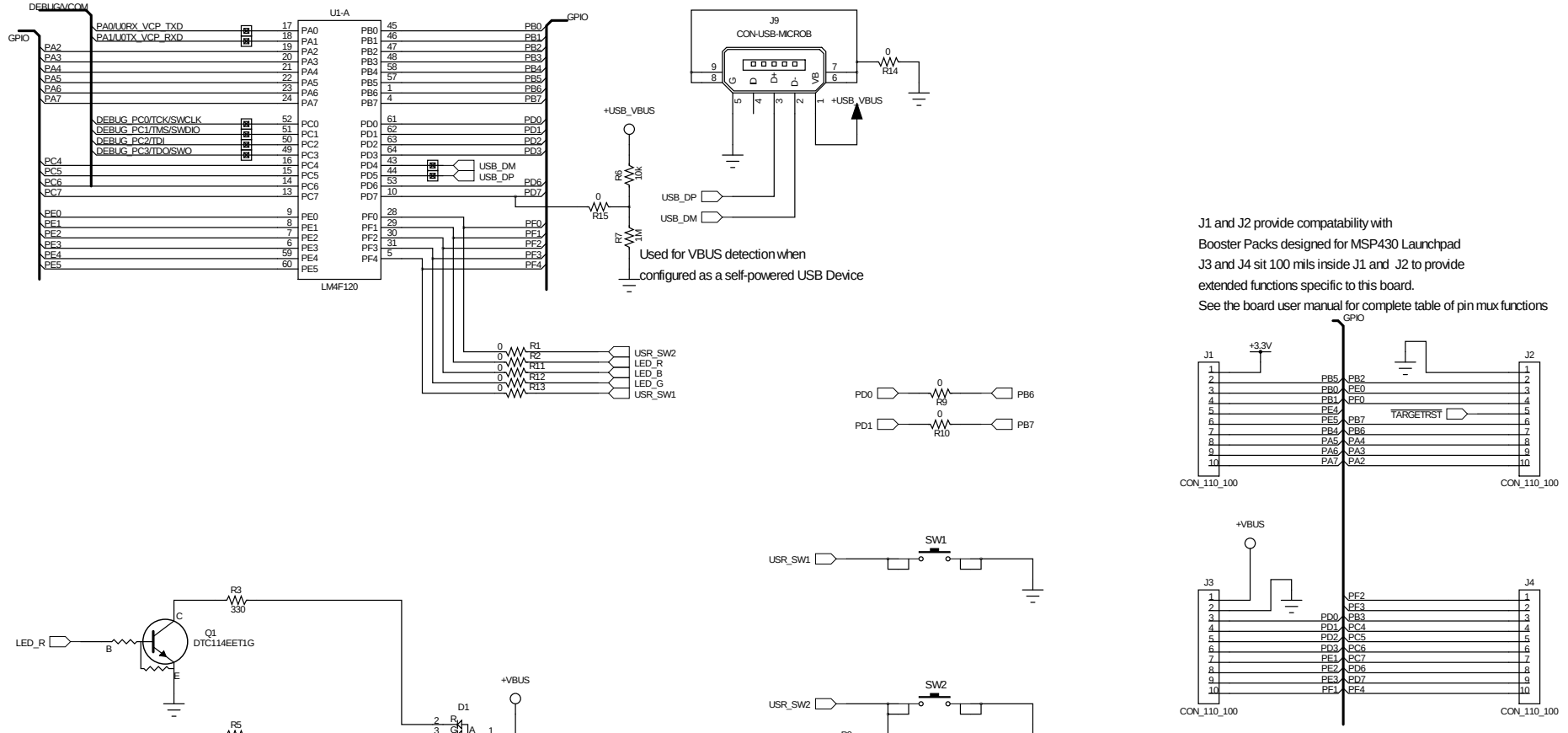
  Note: BoosterPacks that extend more than 0.150 inches below the center of the bottom pin will partially cover the Stellaris LaunchPad user switches which can result in lost user access to those user inputs.
- BoosterPacks are not restricted in width and may extend as much as desired left and right of the Stellaris LaunchPad.
- For BoosterPacks with RF antennas, place the antenna to the left or right of the Stellaris LaunchPad for minimal interference and signal attenuation.
- The BoosterPack interface does not provide any means of keying or alignment guidance. It is recommended that visual cues be provided on the BoosterPack to assist user in proper orientation of the BoosterPack.
- If possible, design the BoosterPack so that incorrect mating to a Stellaris LaunchPad will not damage the BoosterPack.

A P P E N D I X A

Schematics

This section contains the schematics for the Stellaris® LaunchPad evaluation board:

- Microcontroller, USB, Expansion, Buttons, and LED on page 14
- Power Management on page 15
- Stellaris In-Circuit Debug Interface (ICDI) on page 16



DESIGNER	REVISION	DATE
DGT	0.1	8/23/2012

PROJECT: Stellaris Launchpad

DESCRIPTION: Microcontroller, USB, Expansion, Buttons and LED

FILENAME: EK-LM4F120XL Rev A.sch

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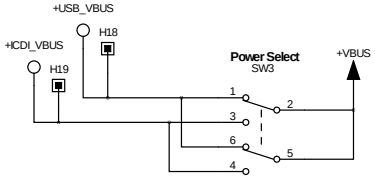
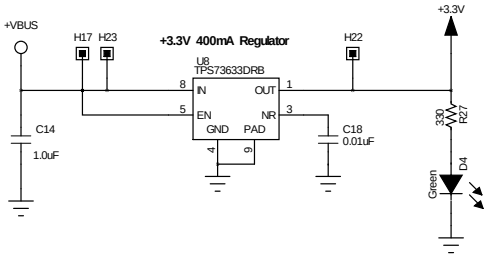
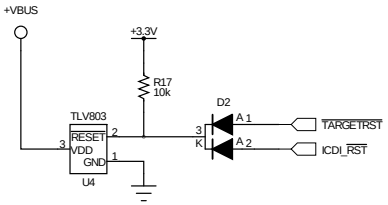
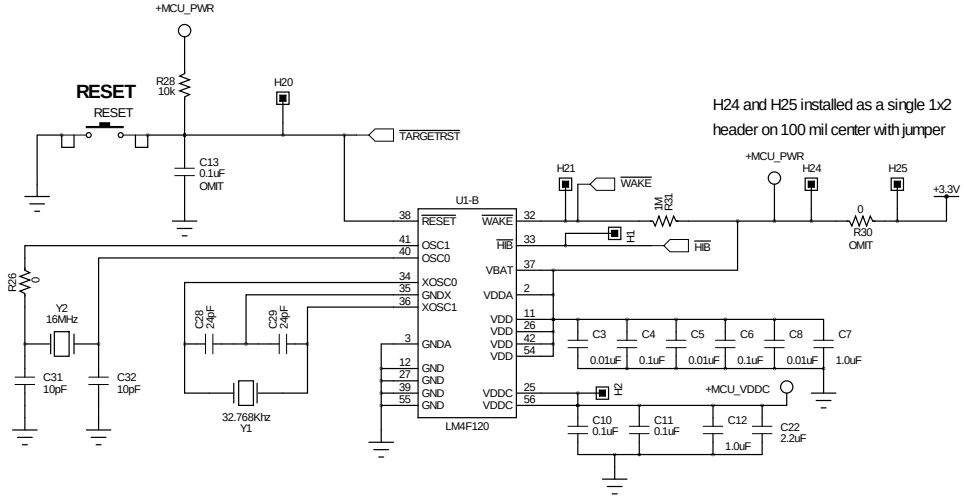
SHEET 1 OF 3

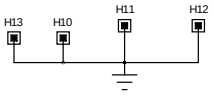








H24 and H25 installed as a single 1x2 header on 100 mil center with jumper



DESIGNER	REVISION	DATE
DGT	0.1	8/23/2012

PROJECT: Stellaris Launchpad

DESCRIPTION: Power Management

FILENAME: EK-LM4F120XL Rev A.sch

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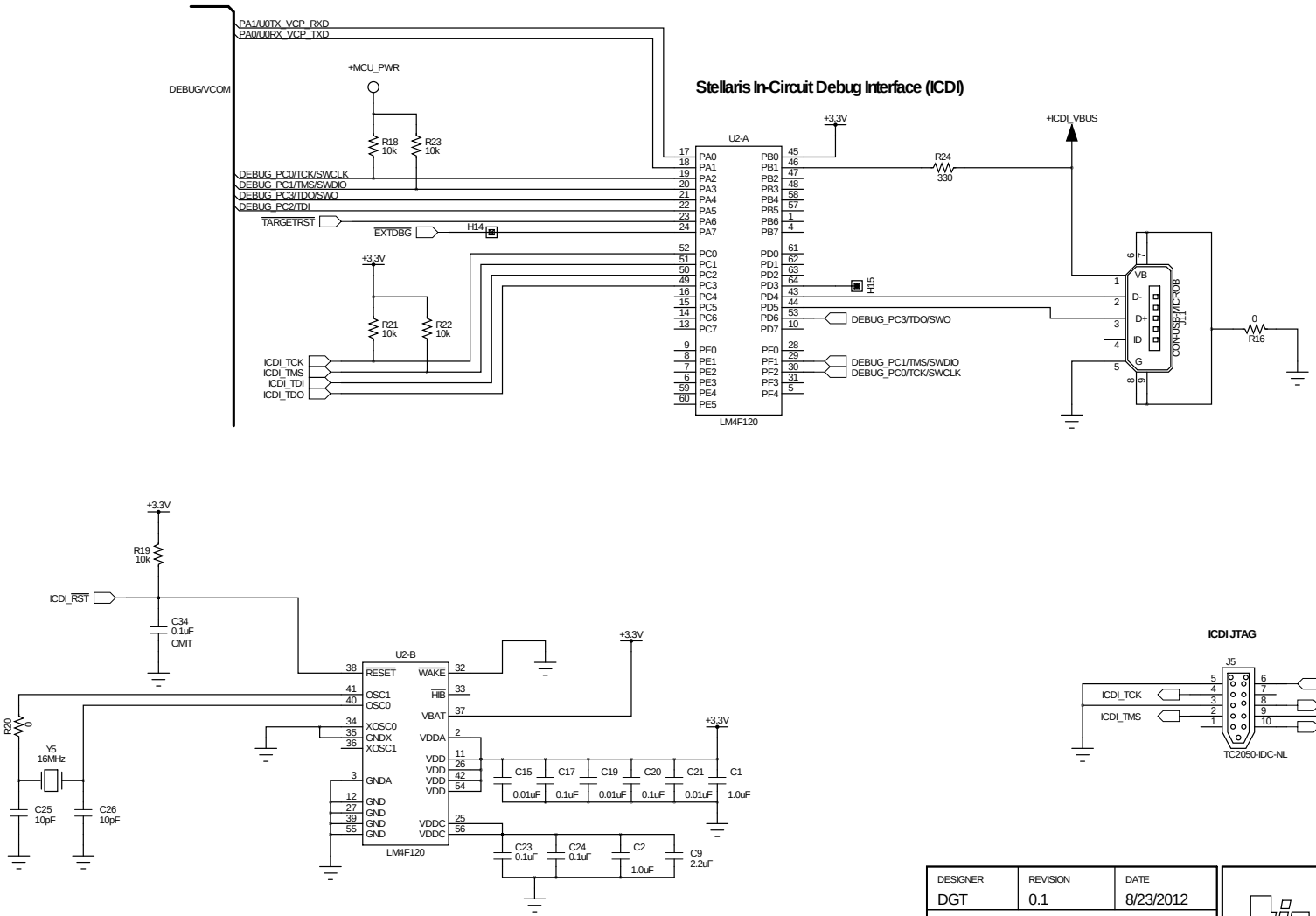

DESIGNER	REVISION	DATE
DGT	0.1	8/23/2012

PROJECT
Stellaris Launchpad

DESCRIPTION
SStellaris In Circuit Debug Interface

FILENAME
EK-LM4F120XL Rev A.sch

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A P P E N D I X B

References

In addition to this document, the following references are included on the Stellaris LaunchPad Evaluation Kit CD and are also available for download at www.ti.com.

- *Stellaris LaunchPad (EK-LM4120XL) User's Manua*l, publication EK-LM4F120-XL
- *Stellaris LM4F120H5QRFIG Microcontroller Data Sheet*, publication DS-LM4F120H5QR
- StellarisWare® Driver Library
- *StellarisWare® Driver Library User's Manual*, publication SW-DRL-UG

Information on development tool being used:

- Texas Instruments' Code Composer Studio™ IDE web site, www.ti.com/ccs

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